

Proof of Performance Report

Customer:

Hapag-Lloyd

Vessel:

M/V Colombo Express

Product:

Mobilgard™ 560 VS

Engine:

Hyundai-MAN B&W 12K98ME

Benefit:

Minimising wear and deposits helps extend engine life, reduce maintenance costs and lessen a ship's environmental impact, whilst simplifying operations with a variable-sulphur cylinder oil.

Mobil Gard™

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Proof of Performance: Mobilgard™ 560 VS

Benefit Summary

Mobilgard™ 560 VS is an all-new cylinder oil formulated to respond to changes in marine engine designs and the evolving conditions in which today's ocean-going vessels operate. In particular, it provides a solution to challenges resulting from tightening emissions standards that require ships to use low-sulphur fuels when in designated Emission Control Areas (ECAs). The oil delivers outstanding performance for two-stroke marine diesel engines operating under extreme conditions that might include slow-steaming, reduced cylinder oil feed rates, and the use of both high- and low-sulphur residual fuels.

At inspections conducted onboard the container vessel *M/V Colombo Express* owned by Hapag-Lloyd of Hamburg, Germany, and operated on heavy fuel oil with less than one percent sulphur content, engineers from MAN Diesel & Turbo and ExxonMobil compared the performance of Mobilgard 560 VS cylinder oil (BN 60) to that of Mobilgard™ L540 (BN 40) in the vessel's Hyundai-MAN B&W 12K98ME engine. For comparative purposes, two cylinders were lubricated with Mobilgard 560 VS, and the others were lubricated with Mobilgard L540.

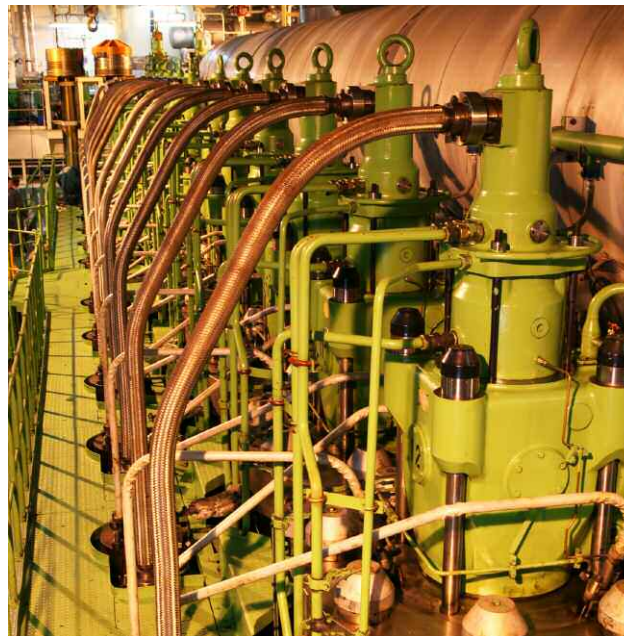
Measuring the piston ring coating thickness and deposits in conjunction with regular port inspections allowed the engineers to closely monitor the oil performance during the test. Onboard, on-line and laboratory analyses of cylinder oil scrapedown samples enabled the engineers to gauge engine wear between inspections.

At the final inspection, Mobilgard 560 VS was shown to provide extremely low piston ring and cylinder liner wear rates and fewer overall piston deposits when compared to the units lubricated with Mobilgard L540.

Overall performance was such that engineers recommended the use of Mobilgard 560 VS on all units, verifying that the oil's performance was effective for use with fuels containing low sulphur.

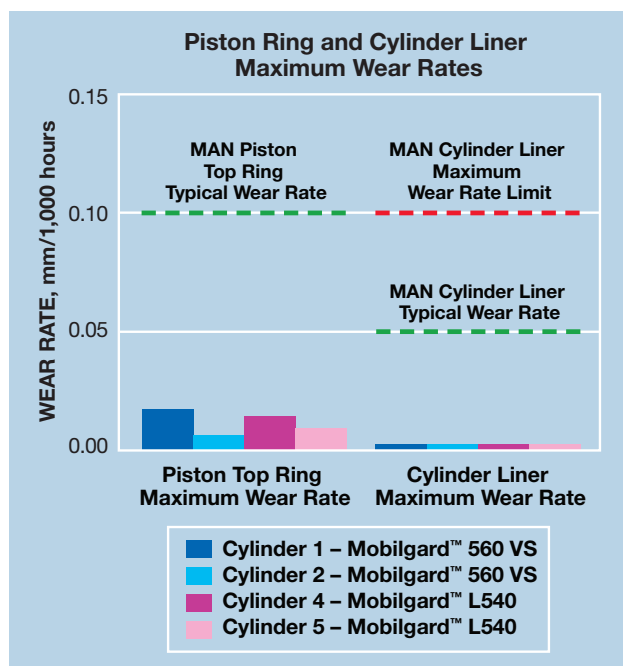
Mobilgard 560 VS is a variable sulphur solution that can also be used with fuels containing high sulphur content. It is designed and tested to operate in engines burning residual fuels containing up to 4 percent sulphur, thus eliminating the need for multiple cylinder oils. This helps save time and storage space, and also helps reduce the risk of human error.

Minimising wear and deposits can help extend engine life, reduce maintenance costs and lessen a ship's environmental impact, whilst simplifying operations with a variable-sulphur cylinder oil.



Hyundai-MAN B&W 12K98ME

A head-to-head comparison of new Mobilgard™ 560 VS and Mobilgard™ L540 confirmed the new oil's ability to provide superior piston deposit control and extremely low wear rates when burning low-sulfur content HFO.



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Proof of Performance: Mobilgard™ 560 VS

Situation

Evolving international emission standards, changes in operating speeds and cost-saving reductions in cylinder oil feed rates contribute to unprecedented operating challenges for today's two-stroke marine diesel engines, many of which now must perform at levels beyond the capabilities conceived for their original designs. Increasingly, ship operators are focussing on the capacity of cylinder oil to protect engines operating under severe conditions and burning fuel with variable sulphur content. To respond to those challenges and conditions, ExxonMobil developed Mobilgard™ 560 VS.

Before launching Mobilgard 560 VS, ExxonMobil conducted extensive tests on the product both in the laboratory and in vessels at sea. This included field tests onboard *M/V Colombo Express*, a containership owned by Hapag-Lloyd and powered by a MAN B&W Hyundai 12K98ME main engine. Of particular interest was the performance of Mobilgard™ 560 VS when used with low-sulphur fuels.

Establishing Benchmarks – Shanghai Inspection

To establish benchmarks for the new oil, ExxonMobil and Hapag-Lloyd evaluated the engine condition of *M/V Colombo Express* at the Huarun Dadong Dockyard in Shanghai in March 2010.

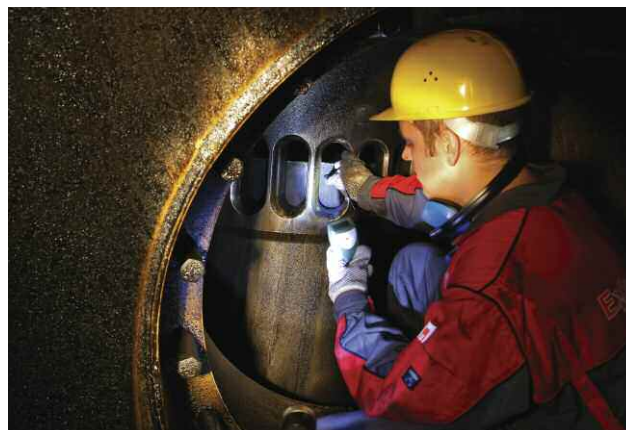
The evaluation also included an assessment of the operating data for the preceding year, including liner temperatures, cylinder oil feed rates, load patterns, exhaust temperatures, and fuel properties. The process also included evaluation of engine and related maintenance information, such as hours of operation of each piston, piston ring set and cylinder liner.

The visual scavenge port inspection showed good cylinder condition. Ring packs were clean, no deposits in ring gaps were found and the piston ring movements were unhindered. Liner surfaces still retained their visible machining marks and the cleanliness was similar and acceptable.

Operations at Sea

Mobilgard 560 VS and Mobilgard L540 were tested as *M/V Colombo Express* sailed to ports that included Antwerp, Rotterdam, Singapore, Pusan and Seattle. Overall period of operation on low-S (<1% S) HFO was 3,532 hours.

The test and reference units were continuously monitored using the onboard LinerScan equipment, which evaluated the iron content in the cylinder scrapedown oil. This allowed engineers onboard the vessel, and ExxonMobil, to continuously gauge engine wear. During the test, the vessel generally ran under a slow-steaming pattern of 30 to 40 percent load.



Test results confirmed that Mobilgard™ 560 VS helped minimise engine wear and deposits, despite challenges that included slow steaming and the use of low-sulphur residual fuels.

Follow-up Investigation – Seattle Inspection

The final inspection took place February 2012 in Seattle, Washington. The test and reference units were visually inspected and measured by engineers from MAN Diesel & Turbo and ExxonMobil.

The assessment also reviewed the previous two year's wear history and included a scavenge port inspection of all cylinders. The findings: piston top ring and cylinder liner wear rates were extremely low during the period of operation on low-S HFO and the piston deposit control performance of Mobilgard 560 VS was excellent, even beyond that of Mobilgard L540.

During the port inspection, engineers measured the wear rates of the piston ring grooves, piston rings, piston crowns, and cylinder liners. They also monitored the residual TBN levels of scrapedown oils for comparison purposes. Engineers noted that although the residual TBN of the scrapedown oil was quite a bit higher than typical on the Mobilgard 560 VS-lubricated test units, the desired light corrosion of the liner surface remained apparent, and no bore polishing observed as piston and ring deposits had been thoroughly controlled during low-sulphur fuel operation.

On the basis of the outstanding performance in this head-to-head comparison between the two oils, engineers recommended the use of Mobilgard 560 VS oil on all units. The new oil was found to be very effective with low-sulphur fuels.

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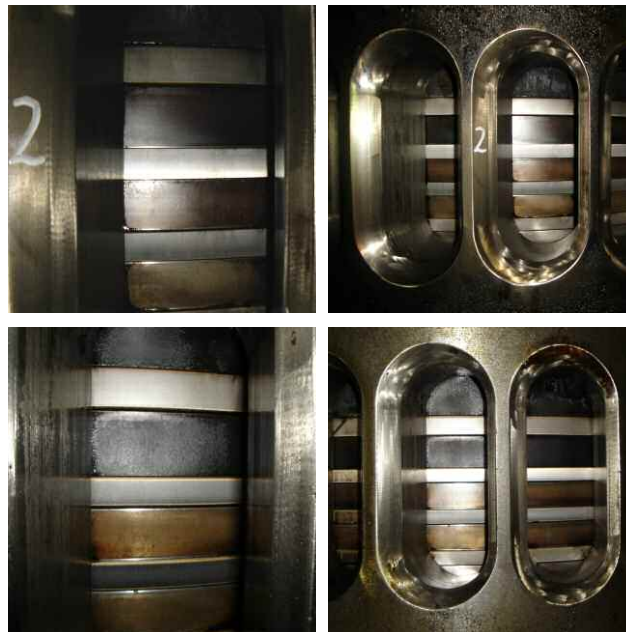
Proof of Performance: Mobilgard™ 560 VS

Solution

With freight rates under pressure, engine designs constantly changing, and emissions regulations ever tightening, the need for a cylinder oil formulated to deliver outstanding performance under tough operating conditions and at both high- and low-sulphur levels has never been greater. Mobilgard™ 560 VS delivers a single solution that helps reduce wear, extend engine life, and ensure optimal reliability.

The proprietary formulation used in Mobilgard 560 VS provides outstanding piston deposit and wear control, plus effective neutralisation and anti-corrosion performance.

Testing conducted onboard *M/V Colombo Express* confirmed the excellent piston deposit control performance of Mobilgard 560 VS.



After 3,532 hours in a Hyundai-MAN B&W 12K98ME engine burning low-sulphur fuel, components lubricated with Mobilgard™ 560 VS had minimal deposits and negligible wear.

Impact

The results of more than 3,532 hours of in-service testing in *M/V Colombo Express*' Hyundai-MAN B&W 12K98ME engine confirmed Mobilgard 560 VS's ability to minimise engine wear and deposits, despite challenges that included slow-steaming operations and the use of low-sulphur residual fuel. The product's outstanding performance can help extend engine life, reduce maintenance costs and lessen a ship's environmental impact.

Mobilgard 560 VS is endorsed by engine builders MAN Diesel & Turbo, Wärtsilä and Mitsubishi Heavy Industries for use in two-stroke marine diesel engines burning both high- and low-sulphur residual fuels.



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Appendix: Hapag-Lloyd Customer Profile

Hapag-Lloyd is one of the largest container shipping lines in the world. For more than 165 years, the Hamburg-based company has set industry-wide benchmarks for reliability, service, productivity and environmental protection. It operates a fleet of about 150 modern vessels and transports more than five million containers (TEU) annually. At present, Hapag-Lloyd employs approximately 6,970 employees at 300 locations in 114 countries.

ExxonMobil's 30+-year business relationship with Hapag-Lloyd has included several joint engineering projects. For more information on Hapag-Lloyd, please visit www.hapag-lloyd.com.



ExxonMobil Marine Lubricants has worked with Hapag-Lloyd for more than 30 years. The business relationship includes providing product to M/V Colombo Express, a 8,749 TEU containership built in 2005.